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1994 Feature Article - "Real" Estimates in the National Accounts

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Introduction

The function of the Australian national accounts is to provide a comprehensive and coherent summary of the economic activity of the nation. A central feature of the national accounts is the presentation of statistics which show the value of production, who has produced it, the income flowing from that production and the expenditure of that income over a period. The most prominent national accounts statistic is gross domestic product (GDP) which measures the total market value of goods and services produced in Australia over a period after deducting the cost of goods and services used up in the process of production (intermediate usage or consumption), but before deducting the consumption of fixed capital.

Three measures of GDP

By definition, the value of production in a period must equal the income earned from that production and the expenditure on the goods and services produced. This means that GDP can be derived using three different approaches:

GDP(P): the unduplicated value of all final goods and services produced in the domestic economy (i.e. total gross output less total intermediate usage of goods and services);

GDP(I): the sum of all incomes accruing to the factors of production from domestic production, including net indirect taxes;

GDP(E): the sum of all final expenditures, plus changes in stocks, plus exports of goods and services less imports of goods and services.

Constant price estimates

Constant price estimates of the Australian national accounts were first produced in the early 1960s. The main reason for their introduction was that values expressed in current price terms suffer from the deficiency that the prices underlying the money values are subject to change over time and therefore the growth rates measured in current price terms are a combination of volume and price change. For certain types of analysis it is useful to have measures which focus on the underlying volumes (i.e. measures with the direct effect of changes in prices removed). Essentially, constant price estimates may be thought of as being derived by expressing the value of each component transaction as the product of a price and quantity and by substituting each current price with the corresponding price in the base year. For example, the value of $3,000 of wheat can be expressed in terms of being 20 tonnes at $150 per tonne, or total rent paid in a month for a shop as $5,000, made up of 100 square metres of floor space at $50 per square metre. In these examples, the constant price estimate for each individual transaction clearly can be derived as the product of the quantity and the base year price by substituting that price for the

current price. In practice, however, it is generally not possible to derive constant price estimates in this way and they are usually compiled by dividing the current price estimates by a price index.

The concept of constant price estimation, as discussed above, is one approach to the derivation of “real” estimates. Up until the mid 1980s constant price estimates were the only real estimates compiled by the ABS. At that time, a sharp fall in the exchange rate of the Australian dollar meant that, while the constant price estimates of gross domestic product were providing information (correctly) about movements in the volume of Australian production, they were not identifying the declining purchasing power of the foreign income generated by our exports. It was therefore necessary to produce an alternative real estimate of GDP which was a purchasing power rather than a volume indicator. This measure is discussed below, following a summary of the main issues involved in expressing income measures in real terms.

Real estimates of income measures

Unlike GDP(P) and GDP(E), the constituents of GDP(I) cannot be conceived uniquely as the product of a price and a quantity. While it can be argued that the wages paid to an individual are equal to the product of the number of hours worked and the hourly wage rate, many employees are not paid according to the number of hours worked; also, the supplements paid are generally independent of the number of hours worked. Moreover, from an employee’s perspective, changes in the value of wages and salaries are related more to changes in their purchasing power than to changes in an hourly wage rate. In addition, an employer will be more interested in changes in wage costs per unit of output than in the input measure represented by hours worked. As gross operating surplus is the residual flow of income to the owners of capital after the payment of labour costs and net indirect taxes, there is no way it can be conceived as the product of a price and a quantity. Accordingly, constant price estimates are only derived for the components of GDP(P) and GDP(E), although the theoretical equality of GDP(E) and GDP(l) permits the derivation of a proxy constant price estimate of GDP(l) in total.

Although constant price estimates are not directly affected by price changes, indirect economic effects (such as an increased volume of exports induced by a fall in export prices) will be reflected in constant price GDP. Even if the constant price value of production remains the same, it is possible for the purchasing power of that production to change because of external influences, such as a change in the terms of trade. During the first half of the 1980s, some commentators were using growth in constant price GDP as a proxy for the growth in Australia’s real income. While it had been a reasonable assumption to make for a number of years prior to 1985, the large fall in the Australian dollar in early 1985 led to a sharp decline in Australia’s terms of trade which invalidated this assumption. Therefore, in conjunction with the March quarter 1986 issue of Australian National Accounts, National Income and Expenditure (cat. no. 5206.0), the ABS published an estimate of the real income being generated in the economy. At that stage it was referred to as “constant price gross domestic product adjusted for the terms of trade effect”. It is now called “real gross domestic income”. The differences between real gross domestic income and constant price GDP(l) reflect the effects of changes in the terms of trade on the purchasing power of income earned from Australian exports. The following describes the main features of the estimation of real gross domestic in-come.

The terms of trade index is defined as the ratio of export prices to import prices. In the Australian national accounts, it is derived as the ratio of the implicit price deflator (IPD) for exports of goods and services and the IPD for imports of goods and services. The major impact of a change in the terms of trade is on the volume of imports Australia can purchase with the receipts from a particular volume of exports. For ex-ample, if there is a decline in the terms of trade through a rise in the price of imports relative to the price of exports, then the volume of imports Australia could purchase with the receipts from a fixed volume of exports would be reduced. As a result, the volume of goods and services available in Australia would be reduced even though the volume produced (i.e. constant price GDP) may not have changed.

The terms of trade and real gross domestic in-come

The effect on real gross domestic income of a fall in the terms of trade can be illustrated by a simple example. Assume that wheat is the only good produced in Australia. In year 1, there are 10 million tonnes of wheat produced, priced at $100 per tonne giving a total value of production of wheat of $1,000 million. Part of the wheat (30 per cent, worth $300 million) is exported while the rest is consumed within Australia. Imports in the same period consist only of diesel fuel (1 million kilolitres at $300 per kilolitre resulting in a total value of $300 million). These imports are used up entirely in the process of producing the wheat. Therefore, the value of GDP is $700 million ($1000 million of output less $300 million of inter-mediate usage).

Assume that the only change between year 1 and year 2 is a decline in the terms of trade as a result of a rise in the price of diesel from $300 to $360 per kilolitre. If year 1 is the base period then the IPD for exports will be 100.0 in both years while the IPD for imports will be 100.0 in year 1 and 120.0 in year 2. Thus, the terms of trade have declined from 100.0 to 83.3 between the two years. The same volume of wheat is produced, consumed domestically and exported and the same volume of petroleum is imported. In constant price terms, the expenditure side of the domestic production account in year 2 expressed in year 1 prices will be identical to that for year 1 because there is no change in any of the components or in total GDP at constant prices (all the underlying volumes are identical in both years). However, the expenditure side of the domestic production account for year 2 does change in current price terms. The expenditure side of the production account is shown in the following table:

TABLE 1. THE EXPENDITURE SIDE OF THE PRODUCTION ACCOUNT

	Current price values ($m)		**Constant price values ($m)**	
	Year 1	Year 2	Year 1	Year 2
Private final consumption expenditure	700	700	700	700
Exports	300	300	300	300
less Imports	300	360	300	300
Gross domestic product	700	640	700	700

For year 2 the same result is obtained using the ‘production approach’ to measure current price GDP (i.e. $640 million made up of $1,000 million of output less $360 million of intermediate usage). It is apparent that the income available from the production of the same volume of output has fallen because of the decline in the terms of trade which resulted from the rise in import prices. In the absence of a higher price for wheat on world markets, the only way in which the income from production can be maintained is for physical production to increase.

There is no single agreed way in which to measure the “terms of trade effect” on GDP, but the method adopted in the Australian national accounts is generally accepted as being a suitable way of calculating the adjustment. It also has the advantage of being simple to implement. (In practice, the various methods produce fairly similar results in most circumstances.) In the Australian national accounts, the adjustment has been calculated by revaluing exports of goods and services by the IPD of imports of goods and services to provide a measure of the purchasing power of exports over imports. This value has then been substituted for the actual constant price value of exports of goods and services on the expenditure side of the constant price domestic production account Real gross domestic income has been calculated by summing final expenditures, the changes in stocks and (adjusted) exports less imports.

In the simple example above, the constant price export estimates adjusted for the terms of trade effect would be $250 million, obtained as the current price value ($300 million) deflated by the imports IPD (120.0). The expenditure estimates adjusted for the terms of trade effect would be as follows:

TABLE 2. EXPENDITURE ESTIMATES ADJUSTED FOR THE TERMS OF TRADE

	Real gross domestic income ($m)*	
	Year 1	Year 2
Private final consumption expenditure	700	700
Exports	300	250
less Imports	300	300
Real gross domestic income	700	650

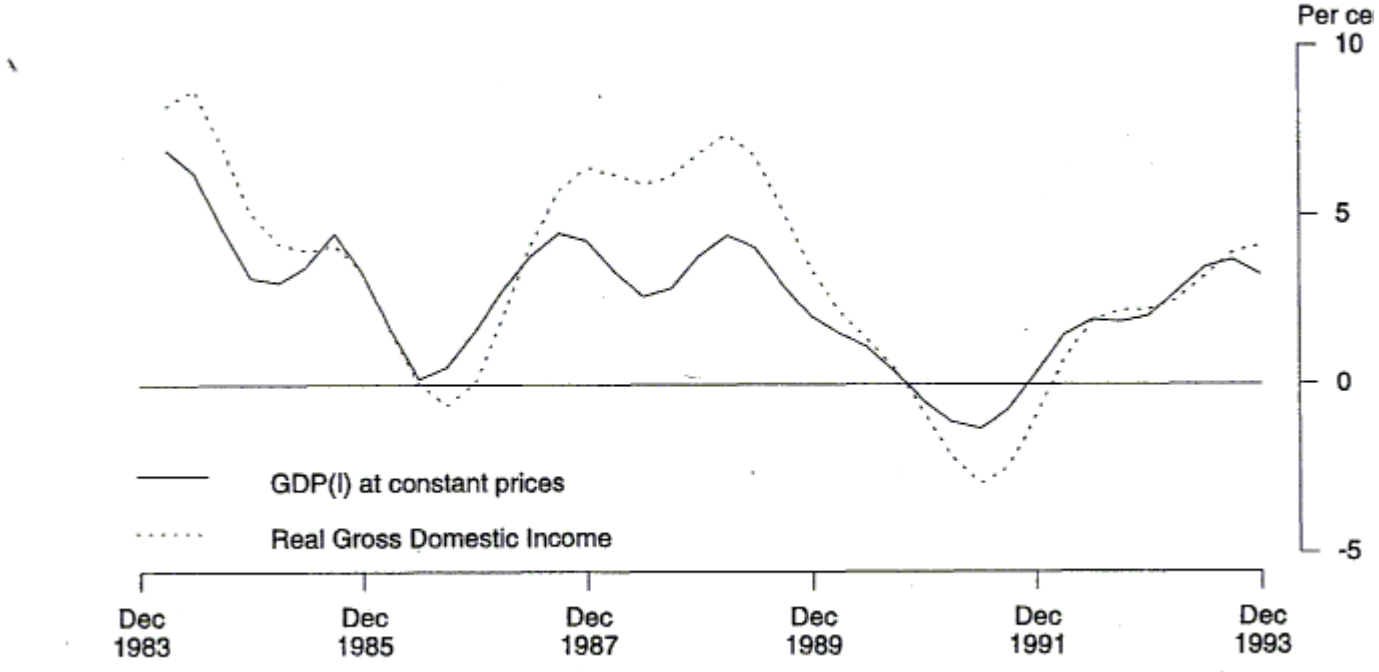
* Expressed in Year 1 prices

In this example, even though there has teen no change in constant price GDP(I) between year 1 and year 2, there has been a decline of 7.1 per cent in real gross domestic income.

Graph 1 below compares movements between the reference period and the same period of the previous year for trend estimates of real gross domestic income and constant price GDP(I) and highlights the effects of movements in the terms of trade. The fall in the terms of trade over 1985, 1986 and 1990 led to weaker growth in gross domestic income than in constant price GDP(I) and the recovery in the terms of trade in 1987 and 1988 resulted in stronger growth in gross domestic income than in constant price GDP(I).

GRAPH 1. REAL GROSS DOMESTIC INCOME AND GDP(I) AT AVERAGE 1989-90 PRICES, TREND

Change from same quarter of previous year



Source: ABS 5206.0

While real gross domestic income was the first estimate published by the ABS which extended beyond the traditional constant price values, further income estimates expressed in real terms have subsequently been released in ABS publications, namely real gross national product and

real household disposable income. In addition, the ABS is working in other areas with the aim of further supplementing the range of traditional constant price estimates published in the Australian national accounts. One such area is chain volume indexes.

Chain volume indexes

As discussed previously, changes over time in Australia's production, as measured by gross domestic product (GDP) in current price terms, reflect the interaction of changes in the physical volumes of the goods and services produced and changes in their prices. Constant price estimates of GDP are derived by expressing transactions in terms of the prices of a base year in order to eliminate the direct effects of price change and allow movements in the underlying volumes to be analysed. Although these constant price estimates are traditionally rebased every five years, for some aggregates this may not be sufficiently frequent. Chain volume indexes are frequently rebased estimates with the price weights always reflecting the price relativities relevant to the reference period. Thus such chain volume indexes provide better indicators of growth than the more conventional constant price estimates in situations where the price and volume relativities of major components change rapidly over time. This is currently occurring to varying degrees for aggregates with computer equipment as a substantial component. Computer equipment prices have been falling rapidly and usage has been growing at a faster rate than for most other goods. In these circumstances the traditional constant price estimates will be inaccurate indicators of growth. The solution is to construct chain indexes, i.e. the accumulation of quarterly or annual volume indexes, in which each successive volume index is derived using the price relativities pertaining at the time.

Laspeyres volume indexes

The constant price value of a good or service at time n is the product of the quantity at time n and the price in the base period. Aggregate constant price values are simply the sum of the constant price estimates of their components, i.e.

Total constant price value at time n = $\Sigma p_0 q_n$

where p_0 is the price of a good or service in the base period and q_n is the quantity at time n. In effect, the prices in the base period (p_0) are the weights used to combine the quantities of each component. When the constant price values of an aggregate are compared over time, an inaccurate measure of growth will result if the weights have changed appreciably from the base period.

A commonly used index for measuring volume growth is the Laspeyres volume index. A Laspeyres volume index may be defined as a weighted average of quantity relatives, the weights being the prices of the goods and services in the earlier of the two periods being compared. A Laspeyres volume index comparing values at times t and n takes the form:

$$L_q = \frac{\Sigma p_t q_n}{\Sigma p_t q_t}$$

In general, it is best to calculate a volume index spanning a number of periods by chaining together volume indexes calculated over consecutive time periods. A chain Laspeyres volume index connecting periods 0 and n takes the following form:

$$L_q^c = \frac{\Sigma p_0 q_1}{\Sigma p_0 q_0} X \frac{\Sigma p_1 q_2}{\Sigma p_1 q_1} X \ \ldots\ldots \frac{\Sigma p_{n-1} q_n}{\Sigma p_{n-1} q_{n-1}}$$

Paasche volume index

Closely related to the Laspeyres index is the Paasche index, which can be thought of as the mirror image of its Laspeyres counterpart. A Paasche volume index may be defined as a weighted average of quantity relatives, the weights being the prices of the goods and services in the later of the two periods being compared. A Paasche index comparing values at times t and n takes the following form:

$$P_q = \frac{\Sigma p_n q_n}{\Sigma p_n q_t}$$

A chain Paasche volume index is obtained by adding 1 to each of the price subscripts in the formula for the chain Laspeyres index to produce the following formula:

$$P_q^c = \frac{\Sigma p_1 q_1}{\Sigma p_1 q_0} X \frac{\Sigma p_2 q_2}{\Sigma p_2 q_1} X \ \ldots\ldots \frac{\Sigma p_n q_n}{\Sigma p_n q_{n-1}}$$

Fisher Ideal volume indexes

The 1993 System of National Accounts (SNA) states that the best volume index in most circumstances is a chain Fisher Ideal index, which is derived as the geometric mean of a chain Laspeyres index and a chain Paasche index. Such indexes have a number of desirable properties, including the fact that they satisfy the ‘time reversal’ test. This means that if all the price and quantity changes that occur between period 0 and t are subsequently reversed between and n, the chain Fisher index linking 0 to n through t returns to unity. Neither the chain Laspeyres nor chain Paasche indexes share this property and so they are more susceptible to ‘drift’ (due to fluctuations in price and volume relativities) than the Fisher index. Nevertheless, the revised SNA states that a chain Laspeyres index is likely to provide a reasonable alternative to a chain Fisher index.

Comparison of alternative volume indexes

The table below presents three volume indexes of imports of goods - an aggregate which has a significant computer equipment component. The first two are indexes of the constant price estimate at average 1984-85 prices and 1989-90 prices, respectively, and the third is a chain Laspeyres index. All three have been re-referenced to 1984-85 = 100.0. (It has not been possible to update the series beyond 1991-92 because constant price estimates on a 1984-85 base have not been compiled beyond 1991-92.)

TABLE 3. VOLUME INDEXES OF IMPORTS OF GOODS(a)

Year	Base 1984-85	Base 1989-90	Chain Laspeyres

1979-80	73.2	73.1	72.4
1980-81	81.2	81.5	81.3
1981-82	91.0	91.6	90.9
1982-83	80.8	80.5	81.1
1983-84	85.6	86.0	85.8
1984-85	100.0	100.0	100.0
1985-86	103.5	102.8	103.7
1986-87	100.6	96.3	99.2
1987-88	110.1	104.9	108.1
1988-89	137.3	130.6	135.0
1989-90	143.8	135.8	140.4
1990-91	139.1	129.5	133.9
1991-92	146.8	135.1	139.5

(a) The chain Laspeyres index has been derived via a simple annual rebasing of the estimates at average 1989-90 prices for each of the 67 SITC divisions, but with no rebasing below this level. Thus, these estimates do not constitute a complete rebasing. It should also be noted that while differences between the growth rates of the 1984-85 and 1989-90 base year estimates mostly reflect rebase effects, they also partly reflect changes in methods.

Consider the growth rate between the two years 1984-85 and 1989-90. According to the 1984-85 base year estimates, the volume of imports grew by 43.8 per cent, but according to the 1989-90 base year estimates, the volume of imports grew by only 35.8 per cent. Without the methodological improvements introduced with the 1989-90 based estimates, the latter growth rate would have been even lower. However, ignoring the methodological improvements and viewing the matter conceptually, it can be said that neither is more correct than the other. In the first case 1984-85 price relativities are used, while in the second case 1989-90 price relativities are used. The standard percentage change formula can be expressed as follows:

Percentage change between 1984-85 and 1989-90 = ((Value in 1989-90 / Value in 1984-85) -1) x 100

When the percentage change is calculated at average 1984-85 prices the quotient in the brackets is a Laspeyres volume index, but when the percent-age change is calculated at average 1989-90 prices the quotient is a Paasche volume index. A better indicator of the growth between the two years is obtained by computing the geometric mean of the two, to give a direct Fisher Ideal index, which indicates growth of 39.7 per cent. In this way both the 1984-85 and 1989-90 price relativities are treated symmetrically. Alternatively, we can refer to the Laspeyres chain index which indicates very similar growth of 40.4 per cent. It can be seen from the table that the chain Laspeyres index calculated for imports of goods generally follows an intermediate path between the 1984-85 and 1989-90 based constant price estimates, and provides a superior indicator of the growth in volume because it takes account of the changing price relativities.

ABS plans to produce chain indexes

The development of systems to produce chain volume indexes for publication is underway at the ABS. Experimental Fisher and Laspeyres type chain indexes will be derived from annually rebased constant price estimates for selected series, including imports and private capital expenditure on equipment. These aggregates have been chosen because they are the components most affected by the ‘computer equipment price problem’. It is intended to publish such estimates in addition to the existing five-yearly rebased constant price estimates rather than as a replacement for them. Any improvement in estimates of growth yielded by these estimates is at the expense of the additivity between components and aggregates which is a feature of unlinked constant price estimates.

Summary

A variety of real measures may be derived from one particular flow or stock estimate, reflecting

the different perspectives of a number of transactors or the choice of factors such as the base period. In some instances, such as analysing estimates within an accounting framework, additivity may be essential and constant price estimates will be more useful than volume indexes. In other cases the focus may be on growth in components and aggregates individually and therefore chain volume indexes may prove more useful. Similarly, there will be situations where real measures, reflecting changes in purchasing power, are more relevant than constant price estimates which reflect changes in volumes of activity. Neither real nor constant price estimates are unique measures and users need to consider their characteristics in deciding on the appropriate real indicator for their application.

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